

The Ecology of Medical Care: Origins and Implications for Population-Based Healthcare Research

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During the early 1950s the University of North Carolina at Chapel Hill expanded from a two-year to a four-year medical school (the first new school after World War II) and created a new school of public health. Bernard Greenberg, Frank Williams, Dan Martin, Bob Huntley, and I were among the first faculty members appointed. As a consequence of our attempts to bridge the emerging gulf between public health and medicine, those of us in the medical school arranged for several faculty members of the School of Public Health to teach in our classes. These included Bernie Greenberg, then chairman of the department of biostatistics and later dean of his school, and his colleagues, Sydney Kark and the late John Cassel, two pioneering social epidemiologists. Several of us, in turn, participated in seminars and as thesis advisors in the School of Public Health. From the very beginning our friendships flourished. About 1954, in addition to our teaching innovations, we established what we called a Medical Care Research Group—one of the first, if not the first, in the country. We undertook what we then thought was a relatively new line of enquiry concerned with patient referral patterns, the adequacy of communications between patients and physicians and, among physicians, the quality of care, and randomized clinical trials.

Most of this research was centered in what we called a “General Medicine Clinic,” which William Fleming, chairman of preventive medicine, Frank Williams, and I ran. Undergraduates and residents, as well as all faculty members in the department of internal medicine, had extended rotations and assignments in the General Clinic coping with the problems of general medical patients. The goal was to expose all faculty, medical students, and residents in the department of medicine to the problems faced by “generalists.” In addition, we were committed to preparing adequate numbers of “general physicians” for North Carolina as promised to its state legislature in return for the funding of UNC’s new medical school.

Bernie Greenberg also helped frequently with problems in research design, tutored us patiently, and was largely responsible for enlarging my own interest and knowledge of health statistics as distinguished from biostatistics. Several of us, guided by Bernie, also participated in one of the first double-blind randomized control studies conducted in this country—but that is another story (Dorsett, Woods, White, et al. 1958). Now on to the origins of the logo adopted for this Institute with which my name is now associated, and its initial publication in “The Ecology of Medical Care” in *The New England Journal of Medicine* in 1961 (White, Williams, and Greenberg 1961).

In the fall of 1960 I returned from a sabbatical year in London to Chapel Hill where I was an associate professor of internal medicine. Charles Burnett, the original chairman of that department, who had hired me, was absent because of a long-lasting illness. His deputy, the late Louis Welt, a highly skilled and widely regarded nephrologist, replaced him as chairman. Lou believed that medicine’s future lay in the direction of ever-increasing sub-specialization. To his everlasting credit he later changed his views substantially, but at that period he saw the General Clinic and all its works as an outmoded and generally ill-conceived effort. He intended to see it replaced by an ever-increasing series of sub-specialty clinics.

Chuck Burnett had a broad view of medicine’s mission and had participated enthusiastically in the creation of the General Clinic. The Clinic had a seven-year history of well-received teaching, research, and service supported by the Commonwealth Fund, the Rockefeller Foundation and, of course, the State of North Carolina. Those of us responsible for running the General Clinic were dismayed by Lou’s behavior. I had numerous talks with him about the Clinic’s future and the need for general physicians to provide what we later called, for the first time in the “Ecology” article: “*primary medical care*.” All of these discussions were unsatisfactory from my viewpoint. Sometime early in 1961, Lou and I discussed a forthcoming site visit from the Commonwealth Fund’s officers to assess our progress and the prospects for renewing our grant for the General Clinic. Lou was unimpressed with my insistence that we prepare a written report for the Fund accounting for our use of the grant funds and relating our accomplishments. Lou’s response was, “Just tell them we’ve spent the money!” This reply and the preceding discussion infuriated me. I recall returning to my office and thinking (and later recounting to others), “Lou and his ilk just don’t understand the problems of providing appropriate medical care to all who need it.”

While licking my wounds following this heated altercation with Lou Welt, I determined that the only way to demonstrate the relative needs of

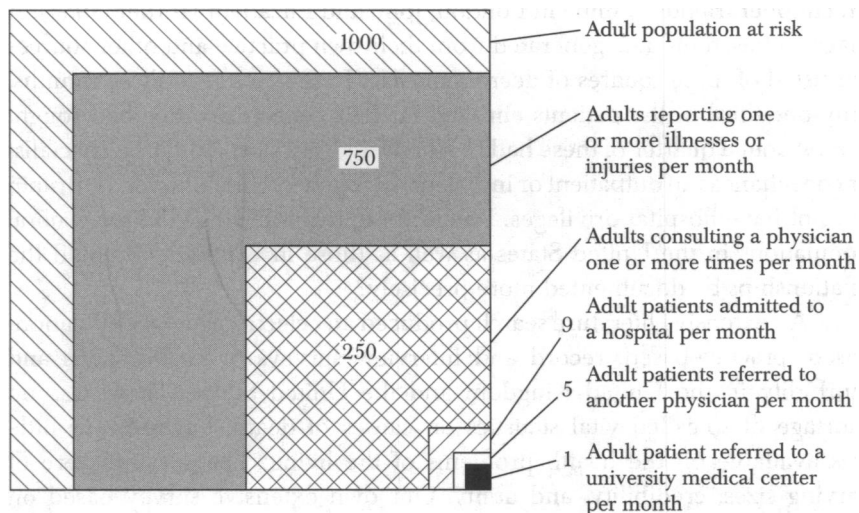
patients and the different requirements for generalists and specialists was with facts. As Alice in Wonderland remarked, "I would sooner see it done on paper with numbers!" I recalled a 1954 article published by two general practitioner friends of mine in London, John and Elizabeth Horder (1954). A diagram based on data generated from their own practice and other sources consisted of three squares of decreasing size. In the course of three months, only one-third of the patients enrolled in their general practice had sought care. About a quarter of these had been referred to a hospital-based specialist or consultant as an outpatient or inpatient since general practitioners in Britain did not have hospital privileges. Would these relationships hold for general populations in the United States as well as those in Britain, and could the relationships be documented more precisely?

An extensive literature search produced an eclectic array of population-based, practice-based, record and interview surveys of health status and morbidity in the United Kingdom and the United States. There was no shortage of so-called vital statistics on causes of death, but precious little was available on the health problems of the living. The surveys were of varying sizes, credibility, and utility. Our own extensive survey based on a probability sample of all community-based physicians in North Carolina and their referred patients was also an important source of data (Williams, White, Andrews, et al. 1960).

Bernie Greenberg was especially helpful in examining the credibility of the available data and our underlying assumptions as we standardized and adjusted the data to one-month periods for general populations of adults over 16 years of age. We used data from both Britain and the United States and had at least two sources to support most of our findings. At any rate, the detailed data and the calculations are all set forth in our original article. Bernie also contributed substantially in helping to design the diagram itself so that the squares were accurately sized to reflect the underlying data (Figure 1).

We submitted the paper to *The New England Journal of Medicine*. Joe Garland, the editor, accepted it almost immediately without any changes in the text, tables, or the diagram. However, he objected strenuously to the term "ecology" in the title. I insisted that the word had to remain and, after an extended long-distance telephone call I made from a pay phone in Atlantic City, he capitulated. Following publication we were widely and severely criticized by many of our colleagues in academic medicine—much of it coming from younger sub-specialists who felt that their future careers were being challenged. Our reply was simple: Specify the inaccuracies and come up with different figures if they exist. The study has been replicated in many

Figure 1: Monthly Prevalence Estimates of Illness in the Community and the Roles of Physicians, Hospitals, and University Medical Centers in the Provision of Medical Care (Adults 16 Years of Age and Over)

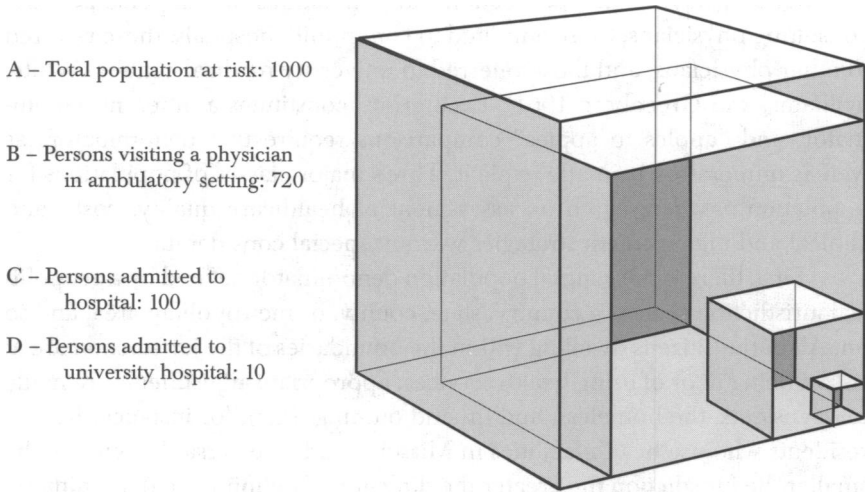


quarters over the decades and the relationships persist. For a 1973 article in *Scientific American* I used national annual data from the National Center for Health Statistics, and the fundamental relationships still held (Figure 2) (White 1973).

Now for the “Ecology” model’s implications for population-based healthcare research. There are three arenas in which the problems of health and disease may be studied: the laboratory, the one-to-one clinical setting, and the population. One is not good or bad, right or wrong, hard or soft. The site selected depends on the problem being addressed and the question being asked. The credibility and utility of the findings are what count.

During the seventeenth, eighteenth, and nineteenth centuries our forebears paid considerable attention to the population dimensions of disease; there were not many useful clinical interventions to offer. In the first half of this century, however, medicine’s increasingly successful focus on the laboratory study of microorganisms and on their eradication was accompanied by a diminished study of health and disease in populations. Only in the last three or four decades has the population perspective resumed its traditional place among the essential sites for furthering the healthcare establishment’s efforts to improve the public’s health (White 1991).

Figure 2: Distribution of Demand for Medical Care by a Typical Population in One Year (1970)



Represented volumetrically in this illustration, distribution points up the discrepancy in scale between the world of medical practice and the world of medical education in the United States. Out of a population at risk of 1,000, an average of 720 people visited a physician in an ambulatory setting at least once, 100 people were admitted to a hospital at least once, and only 10 were admitted to a university hospital at least once.

More recently, new impetus for population-based research has come from the public's increasing insistence that health care be organized effectively and managed efficiently so that the fruits of efficacious biomedical and behavioral research are made available to all who can benefit.

Like most research, healthcare research is concerned with identification and estimation of bias, which of course can never be eliminated completely (White, Frenk, Ordonez, et al. 1992). Nowhere is this of greater concern than in the monitoring and management of healthcare quality. Patients' anecdotes and physicians' testimonials are no longer adequate bases for assessing the impact of individual and collective healthcare interventions. For comparisons of these interventions over time, place, institutions, and systems, we require rates that are appropriately standardized or adjusted for differences in the distributions of groups by age, sex, and other attributes. Calculation of these rates with increasing precision requires both relatively large numbers—generally the larger the better—and clearly defined denominators as well as numerators.

The perspective espoused in "The Ecology of Medical Care" drew attention to the several distinct denominators that extended from general or geographically defined populations, to populations of sick persons, those consulting physicians, those admitted to community hospitals, those referred to other physicians, and those referred to university medical centers (White, Williams, and Greenberg 1961). Each group constitutes a different denominator, and "apples to apples" comparisons require that denominators as well as numerators be made explicit. Three major classes of populations for population-based research on assessment of healthcare quality, costs, and clinical and management strategies warrant special consideration.

First, there is the general population denominator defined by a geopolitical jurisdiction such as a country, state, county, or metropolitan area, and so on. All of the citizens dwelling within the boundaries of the jurisdiction are at risk of being ill or of using health services; appropriate adjustments are made for transients, the homeless, and in- and out-migration, for instance, Kansas residents who use health facilities in Missouri and vice versa. In general, the smaller the jurisdiction the greater the difficulty of defining the denominator.

Second, there is the healthcare system, preferably a vertically integrated system, in which all of the enrollees or subscribers constitute the denominator. Where there is a *National Health Service*, such as that in Great Britain, the denominator is virtually synonymous with the general population or subsets, such as its geographically defined regions. In an entity such as *Medicare* we have an age-determined segment of the population more or less similar to the same age group in the general population. *Health maintenance organizations* and, for example, industrywide insurance programs present other problems. Where the HMO or insurance program is community-rated and the numbers are comparatively large, we approach denominators that may be compared after suitable adjustments to general populations. Where there is experience-rating, and the denominator consists, for example, of younger, healthier, and lower-risk patients or conversely (and much more rarely) of older, sicker, and higher-risk populations, other distortions occur. When numbers are relatively small, comparisons among systems and general populations become more difficult and often impossible.

Finally there are specialized denominators such as all patients using specific practices, services, or institutions. Here denominators can be estimated by various sophisticated statistical maneuvers such as the "capture-recapture" methods first used by wildlife biologists. Randomized clinical trials involve a different set of problems. That is why the 1971 *WHO Expert Committee on Health Statistics*, in first defining terms for evaluating health services, dis-

tinguished between “efficacy” and “effectiveness” (White 1971). Estimates of the relative “efficacy” of an intervention or management strategy are generated from highly selected sets of patients participating in a clinical trial. “Effectiveness” describes the usually different results obtained from assessing the same intervention’s benefits when used by large numbers of unselected physicians treating unselected patients living in their natural habitats. Many undocumented factors influence the practical application of an “efficacious” intervention in the “real world.”

It was William A. Guy who, in the 1850s, first noted the impact of selective bias arising from differences among those sick persons admitted and not admitted to hospitals for similar diseases (Guy 1856). But it took another century before Berkson in 1946 first demonstrated mathematically the importance of selective bias in epidemiological investigations (Berkson 1946). Acknowledgment of the ubiquitous impact of selective bias is now incorporated in etiological, intervention, and healthcare studies. But the identification and measurement of selective bias continues to be a significant problem in studies that employ large databases, especially those involving multi-organizational databases.

Substantial problems remain also with the reliability and validity of the data generated by countless patients, physicians, and other healthcare personnel, as well as with numerous coding and entry clerks in a wide variety of practice settings, institutions, and systems. For example, there are major difficulties in defining all the terms, definitions, and standards that govern the acquisition of the original data; if comparisons across systems are to be made, these need to be standardized. Help arrived with the advent of *Uniform Minimum Data Sets*, now widely used for hospital discharge abstracts and claims forms (Murnaghan and White 1970). They have also been developed for ambulatory care (Murnaghan 1972) and, to a lesser extent, for long-term care (Murnaghan 1975).

But these are not new ideas! It was Sir William Petty, widely regarded as the father of economics and epidemiology, who in the seventeenth century first suggested comparing the outcomes of different health systems, specifically of the hospitals of London and Paris (Greenwood 1948). It was Florence Nightingale who first urged recording the outcomes of hospital admissions and the development of uniform hospital statistics (Nightingale 1860). And it was J. A. Glover, a health officer in Britain, who during the 1930s first documented substantial differences in the tonsillectomy rates for children in what were otherwise similar cities and jurisdictions—later referred to as the “Glover Phenomenon” (Glover 1938).

An example of the contemporary uses of hospital discharge abstract data is to be found in Vermont. In 1962, I was attracted to an opportunity at the University of Vermont because its relatively well-defined general population would facilitate the study of that state's health services, especially its hospital care. Out department proceeded to install a hospital discharge abstract system in all Vermont hospitals to exploit this opportunity. In 1964, after moving to Johns Hopkins, I interested one of our students, Jack Wennberg, in taking a job in Vermont in order to analyze this gold mine of hospital discharge data (Wennberg and Gittlesohn 1973). His superb contributions over the succeeding decades have shown the remarkable power of small-area comparisons for illuminating the complex factors that influence the content and quality of care under different auspices and in different jurisdictions.

There are equally complex problems associated with the labeling of health and medical problems. Each of the several populations depicted by the "ecology" squares requires somewhat different labels or nomenclatures and different classification schemes to describe that population's health problems or—when records are linked as they have been in Manitoba, Canada—the *same* populations as they move through life and the healthcare system (Roos and Roos 1992; Wolfson et al. 1993).

The *International Classification of Diseases* was originally designed for arraying causes of death (World Health Organization 1975). Slight modifications were made over the decades for nonlethal "diseases," and with the Ninth Edition further so-called Clinical Modifications were made (*ICD-9-CM*) to accommodate the need for labels required for hospitalized patients (Commission on Professional and Hospital Activities 1978).

More recently, the *International Classification of Primary Care* was developed for use at that level of care and was widely adopted in Europe (Lamberts and Wood 1987; Lamberts, Wood, and Hofmans-Okkes 1993). It recognizes the long-standing observation that 60 percent of the problems brought by general populations to sources of general or primary care cannot be labeled as "diseases" (College of General Practitioners 1966). They are patients' problems, concerns, complaints, symptoms, and assorted "conditions," including a wide variety of social and psychological problems that are the day-to-day fare of general physicians. These also represent the initial manifestations of what later may be labeled by nurses and physicians as "diseases," some of which may eventually lead to death. The unwarranted bias resulting from attempts to cram every patient's unique problem into a "disease" category leads to huge distortions in measuring the burden of illness in different clinical settings.

When measures of “severity” and “urgency” are lacking, the distortions are compounded.

In addition, of course, we need labels and classifications for *Lay Terms* used by the general public in describing their ailments and concerns. Why should the public be required to describe their problems with the Latin or Greek lingo used by the medical profession? We would undoubtedly obtain more accurate and reliable data by using patients’ own terms as they move through healthcare systems. I don’t expect these changes to come to pass any time soon in this country, but it is of major interest in developing countries. *Reasons for Encounter*—in other words, for seeking care—constitute yet another classification. The patient may bring a problem to the source of care because he or she read about it in the paper or a spouse insisted that “something be done.” And then there are classifications of interventions and procedures of which we have several in vogue; standardization of these is urgently needed.

Related to the problems of labeling, terminology, and definitions are those of classification and coding and the development of thesauruses for the grouping of synonyms. I could go on, but I hope I have made my points. Some entity—I believe it should be the U.S. National Committee on Vital and Health Statistics and the National Center for Health Statistics, with full input from the private and public sectors, state and local as well as national—should be given a broad mandate to develop and disseminate suitably designed and widely accepted *Uniform Minimum Data Sets* and related *Nomenclature, Classification, and Coding Systems*.

There is plenty to build on from domestic and foreign experiences, but we can never attain the full potential of diversity and competition in the evolution of this country’s healthcare systems until we have the capacity to measure and compare. To do this requires clearly defined denominators, numerators, labels, terms, classifications, and coding schemes, as well as uniform standards for acquiring and aggregating data. Just as we have started to compare hospitals to one another by using *Medicare* data, flawed as the data and methods may be, we soon will be comparing each hospital’s experience with that of the entire population in its geopolitical jurisdiction. We are already starting to compare HMOs and related healthcare systems to one another, and these too will be compared increasingly with the experiences of entire general populations. All of this will come to pass, and it is groups such as those represented by this Institute’s membership that will pioneer in developing these essential comparisons of healthcare quality and fiscal management. The public now expects more than ever to receive value for the money it spends.

I hope it is clear that not all of the good ideas are new and that, in my view, many of the new ideas are not all that good! We have greatly improved the statistical methods bequeathed us by the seventeenth-century French statisticians but have not added much to their central ideas. It is no news that everything takes longer, but it is my fond hope that the Institute that bears my name will, with the participation of many others, accelerate the process of developing old and new ideas to improve the quality of care provided for all populations.

This 35-year exercise ends where it started. Any balanced healthcare system that purports to respond to all of the people's health problems effectively, efficiently, and appropriately, requires rational distributions of energy and resources in education, services, and research. Perhaps the wider dissemination of the concepts espoused a generation ago in "The Ecology of Medical Care" will further that objective.

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